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# Clinical Microsystems: A Critical Framework for Crossing the Quality Chasm

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**Abstract:** Patients, payers, and the public have increased expectations concerning the quality, safety and costs of our health care delivery systems. Whether or not to redesign our complex delivery systems is no longer in question. In order to succeed in optimizing care and outcomes (clinical and financial) for our stakeholders, we must design and evaluate tests of change. This journey will require a fundamental shift in our traditional thinking about healthcare delivery systems, including how: (1) each of us relates (effectively or not) to one another, and (2) the value of our patient's care is impacted accordingly. With this challenge in mind, this article will provide insight to the reader concerning clinical microsystems, small groups of professionals who work together on a regular basis to provide care to discrete populations of patients. The reader will learn how to leverage these microsystems to meet our stakeholders' expectations, namely to optimize the quality, safety and costs of our health care delivery systems. **Keywords:** microsystems, quality improvement, quality of care. *JECT. 2014;46:33–37*

Large-scale improvements have been realized in the outcomes for cardiac surgery over the last six decades, driven in part by both technological advances and changes in processes of care. Nonetheless, current care is less than ideal, whether attributed to gaps in our knowledge base, poor clinical decision-making, medication errors, unsafe transitions of care, or ineffective teamwork. Many of us recognize these current shortcomings in our own clinical practices and often create patchwork-like fixes or workarounds to protect our patients from unintended harm.

Some of the most common of these gaps in idealized practices are attributed to the way our clinical teams are organized and how they function and relate within our larger healthcare organizations. In its report, *Crossing the Quality Chasm* (1), the Institute of Medicine (IOM) identified the need to address these deficiencies, in part by optimizing the way small clinical teams, "microsystems," function. The IOM recognized that those most suited to help transform the healthcare delivery system are indeed us, healthcare professionals.

Using a case example from a regional quality improvement project, this article will inform the reader about clinical microsystems and how they may be leveraged to support improvement in the delivery of care. In particular, this article describes the key facets for leveraging the value of microsystems, including methods for engaging teams in the process of clinical redesign.

## DESCRIPTION

Change is inevitable in any organization, although improvement is not. However, we may increase the likelihood that the changes we make will result in improvements in care. First things first: definitions (Figure 1) (2).

Clinical Microsystem: A healthcare clinical microsystem can be defined as a small group of professionals who work together on a regular basis, or as needed, to provide care to discrete populations of patients. It has clinical and business aims, linked processes of care, a shared information environment, and produces services and care that may be measured and leveraged as performance outcomes. These systems evolve over time and are (often) embedded in larger systems or

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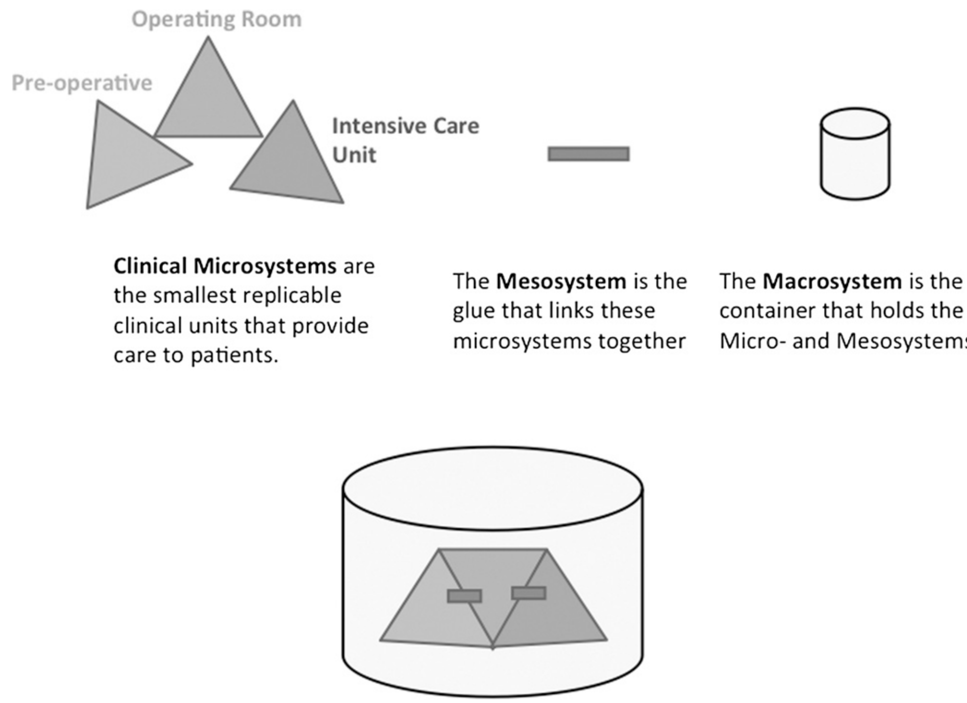


**Figure 1.** Micro-, meso-, and macrosystems.

organizations. These systems and organizations are called "mesosystems" and "macrosystems," respectively.

Mesosystem: Links microsystems together to allow them to move from disparate units to those that support patients along their continuum of care.

Macrosystem: The container that holds meso- and microsystems.

"Microsystems thinking" has evolved over time, although it was derived from statistician and consultant W. Edwards Deming (3) and business school professor James Brian Quinn (4). Dr. Deming taught us that systems by their nature must have an aim, and their subcomponents must work synergistically to achieve the overarching aim (3). Dr. Quinn observed that top performing (in terms of profit, quality, and customer service) Fortune 500 companies were successful as a result of their focus on the smallest replicable units of their business (4). These "best in class" companies achieve their performance targets by empowering frontline teams with knowledge and understanding of their system and its interdependencies within the larger organization. The corporate management recognizes that their workers are the linkage between the organization and the customer. As such, they are best suited to redesign workflow to meet the customer's ever-changing needs. Indeed, these workers also recognize the inherent connections between their own work and their company's other frontline workers.

Drs. Paul Batalden and Eugene Nelson, professors at Dartmouth College, were pioneers in the translation of Deming and Quinn's work to the healthcare sector (5). These investigators envisioned that clinical units such as the operation room are also microsystems (defined in this context as clinical microsystems) (Figure 1). The operating room team, although not traditionally labeling itself in this manner, works together based on shared information and data streams (e.g., the patient record, intraoperative point-of-care blood tests, hemodynamic monitors, and cardiac transesophageal echocardiographic examinations) to serve the patient's needs given a shared business aim (e.g., to repair the patient's mitral regurgitation). Using this framework, we might similarly define other clinical microsystems within a hospital setting, including the cardiac intensive care unit. Importantly, the operating room team transfers the patient to the intensive care unit for postoperative recovery. Many of us recognize that these handoffs are often less than ideal. Why might this be?

Although multifactorial, certainly one culprit is the less-than-ideal transfer of knowledge concerning the patient's operative course (e.g., problems sustaining adequate blood pressure during the bypass period) during the transfer to the unit and connection of monitoring lines. This connectivity between the operating room and intensive care unit microsystems is managed or controlled by what we might call a mesosystem. You could now imagine that there are numerable micro- and mesosystems contained within any healthcare organization. Oversight and coordination of these mesosystems is conducted by a macrosystem, which is usually thought of as a chief operating officer, board of directors, etc.

**Case Example**

In 2002, through a grant from the Agency for Healthcare Research and Quality, a multidisciplinary group of clinicians and quality improvement experts in northern New England embarked on an effort to evaluate the impact of operative practices on mechanisms of brain injury after cardiac surgery. The overarching goals were to: 1) document the association between processes of care and mechanisms of brain injury; and 2) redesign practices to reduce their incidence. To do so, investigators enrolled patients into a noninvasive neuro- and systemic monitoring study (6). Subjects consented to be monitored continuously throughout their cardiac surgical procedure to measure: 1) embolization and oxyhemoglobin desaturation in the brain; 2) embolization leaving and traveling to the patients through the heart–lung machine; and 3) hemodynamics.

The microsystem that we focused on was the operating room team, composed of a cardiothoracic surgeon, physician assistant, anesthesiologist, perfusionist, and scrub nurse. Team members of this microsystem met monthly and were supported by a quality improvement expert and cardiovascular epidemiologist.

The study was broken into four phases: Phase I: understanding our microsystem and gathering baseline data concerning mechanisms producing neurologic injury; Phase II: developing a multidisciplinary quality improvement team (which met monthly) and begin using the intraoperatively collected physiological parameters to make small tests of change; Phase III: using operative data to enhance the operative debriefing period; and Phase IV: making changes to the heart–lung machine to reduce emboli traveling back to the patient. Phases II–IV are particularly pertinent to the theme of this article.

Between Phases II and IV, the team discussed the data that were collected during the operative period and identified opportunities to use this context knowledge (along with generalizable knowledge from the literature) to make targeted quality improvement interventions (Figure 2; Table 1). For instance, our team noted during Phase I that periods of increased vacuum-assisted venous return were associated with emboli in the inflow of the heart–lung machine. These findings were in concert with a prior report from Willcox and colleagues (7). Interestingly, we found that our data feedback identified the interdependencies of each team member's practices as well as the implications of these on embolic activity. For example, our data showed the relationship between the insertion of the coronary sinus catheter and emboli leaving the cardiopulmonary bypass (CPB) circuit and subsequently identified in the middle cerebral arteries. Microsystem team members (surgeons and perfusionists) discussed these findings and alternative strategies to prevent embolic activity associated with the coronary sinus catheter insertion. Two strategies were used, including the insertion of the sinus catheter before initiation of CPB and reducing the amount of vacuum-assisted venous drainage. Additional changes occurred in Phases III and IV, including using rich contextual data to inform the operative debriefing period and strategic changes in the use of oxygenators and pumps, respectively. In all cases, our team shared generalizable and context knowledge to make cogent and sound arguments to support suggested changes to our operative practices. We monitored before and after each of the interventions to determine whether the

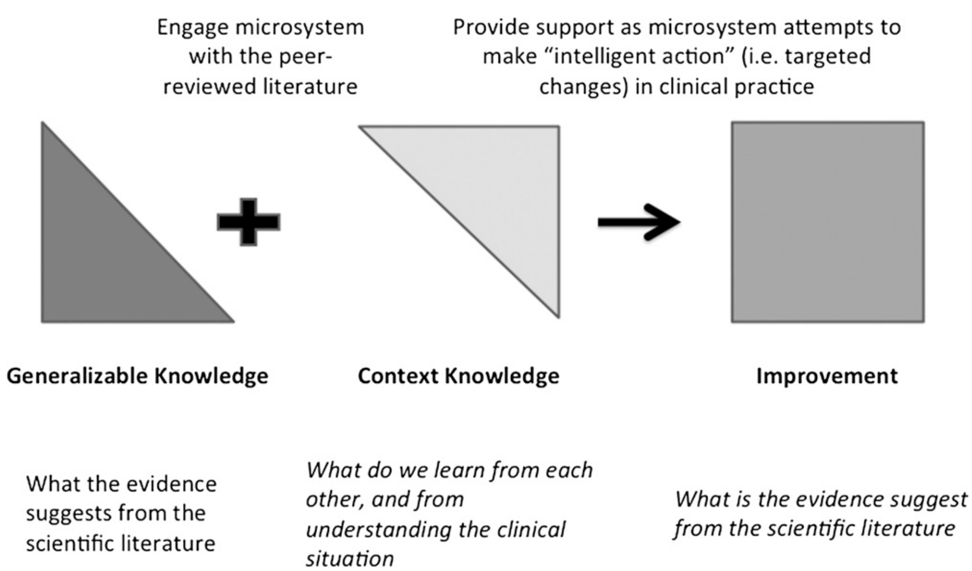


**Figure 2.** Formula for quality improvement.

**Table 1.** Examples of practice changes.

| Microsystem Team Member | Activity | Relevant Literature |
|---|---|---|
| Perfusionist | Reduced use and amount of augmented vacuum | Willcox et al. (7); Rider et al. (10) |
| Surgeon | Single clamp | Hammon et al. (11) |
| Anesthesiologist | Use of ultrasound to guide imaging of aortic disease | Djaiani et al. (12) |

changes resulted in improvements in the quality of care. Over the course of the study, our changes resulted in 87.9% reduction in median microemboli in the outflow of the heart–lung machine and a 77.2% reduction in microemboli detected in the brain, both $p < .001$ (6).

We recognized that our neuromonitoring study had implications beyond the intraoperative period. We hypothesized that microemboli leaving the heart–lung machine would be associated with increased levels of biomarkers of brain injury, including S100β. Prior work by Wandschneider and others (8) has found higher S100β associated with coronary artery bypass graft surgery using a heart–lung machine versus those conducted off-pump. With this generalizable knowledge as an underpinning, we communicated (vis-a-vis our mesosystem) with the pre- and postoperative microsystems to engage in a prospective study of our neuro-monitored patients. Our colleagues drew serum on 71 patients before and 48 hours after surgery. We found a significant increase in terciles of postoperative S100β associated with terciles of microemboli in the outflow of the heart–lung machine (9). These findings were shared broadly throughout Maine Medical Center and our regional quality collaborative through presentations at multidisciplinary grand rounds and webinars.

Teams require attention to maintain their interest and effectiveness. Although our neuromonitoring team enjoyed great success in reducing the frequency of emboli secondary to the redesign of the heart–lung machine, we missed opportunities to turn the next chapter in the story. Instead of creatively redesigning the focus of the project and its constituents, the operating room microsystem's attention was diverted to other important institutional projects and initiatives. Although one could interpret this as a failure of the project and its leadership to retain its relevance, members of this microsystem directed their attention to other strategically important projects.

The findings and methodological approach taken in this specific clinical example have proven useful for other projects at Maine Medical Center. A number of team members applied this thinking and framework through the development of The Coronary Artery Bypass Graft Clinical Transformation Team. This multidisciplinary team applied microsystems thinking toward a "patient readiness for surgery" project, whereby team members maximize the patients' preparedness for surgery by using a checklist and ensuring that all requisite diagnostic tests are used and findings reviewed before surgery. When appropriate, surgery is delayed until the patient is truly ready for surgery.

## DISCUSSION

Fancy terminology often impedes acceptance of useful frameworks. As one who seeks to engage clinical teams in improvement work, I admit that at times I often purposefully resist using much of the terminology embedded within this article. I sense that the use of esoteric terminology is not an effective way of engaging clinicians. Nonetheless, I feel strongly that the conceptual framework derived from Drs. Deming and Quinn is extremely useful, because it provides a clinical and business case supporting the need to focus and empower frontline teams with sound data. Indeed, performance measures should reflect how these teams interact rather than promulgate the outdated notion of solely measuring individual performance.

Although we do not traditionally view them as such, our hospitals and healthcare organizations are made up of hundreds if not thousands of these microsystems. Our challenge is to identify the microsystem(s) in which we work everyday and strive to identify how we can maximize its function and business aims. As we mature in our thinking, we must then turn to how a given microsystem relates to other microsystems within our organization so that our efforts maximize our overall organization's strategic vision. This framework, although not traditionally taught in school, will be increasingly important as our organizations (and society) challenge us with improving our efficiency and reliability.

I now challenge you to identify the clinical microsystem you work in and leverage it to provide safe and effective clinical care.

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